FIG. 1

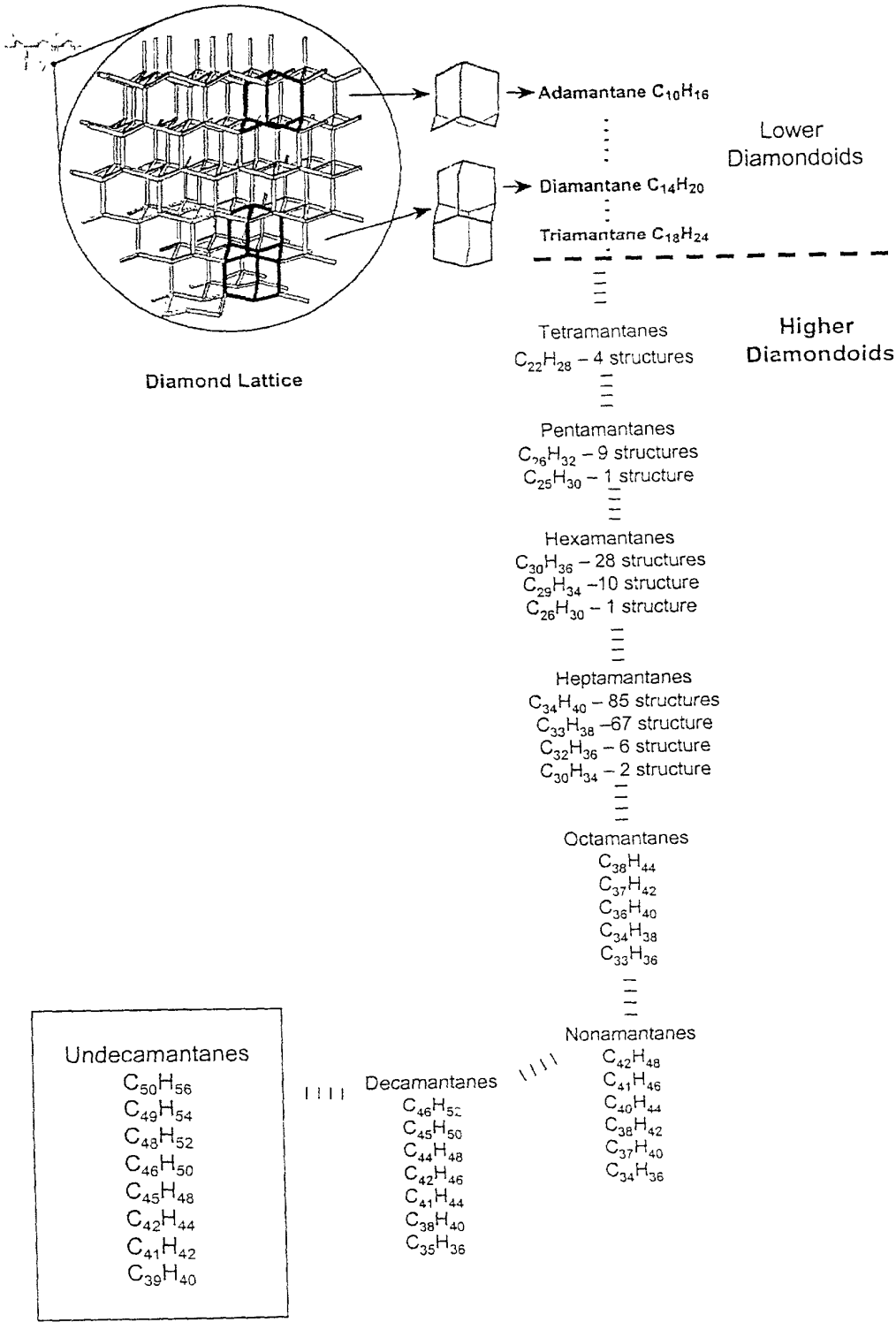


FIG. 2

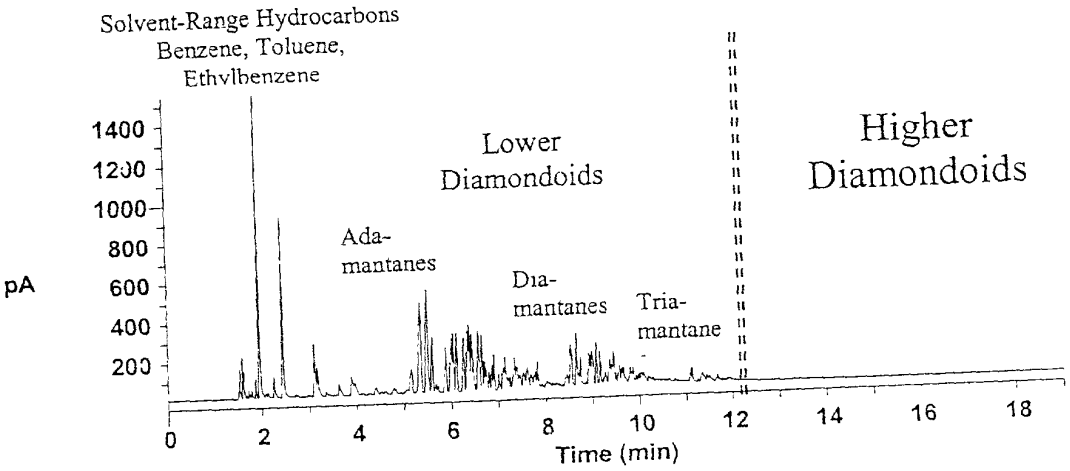
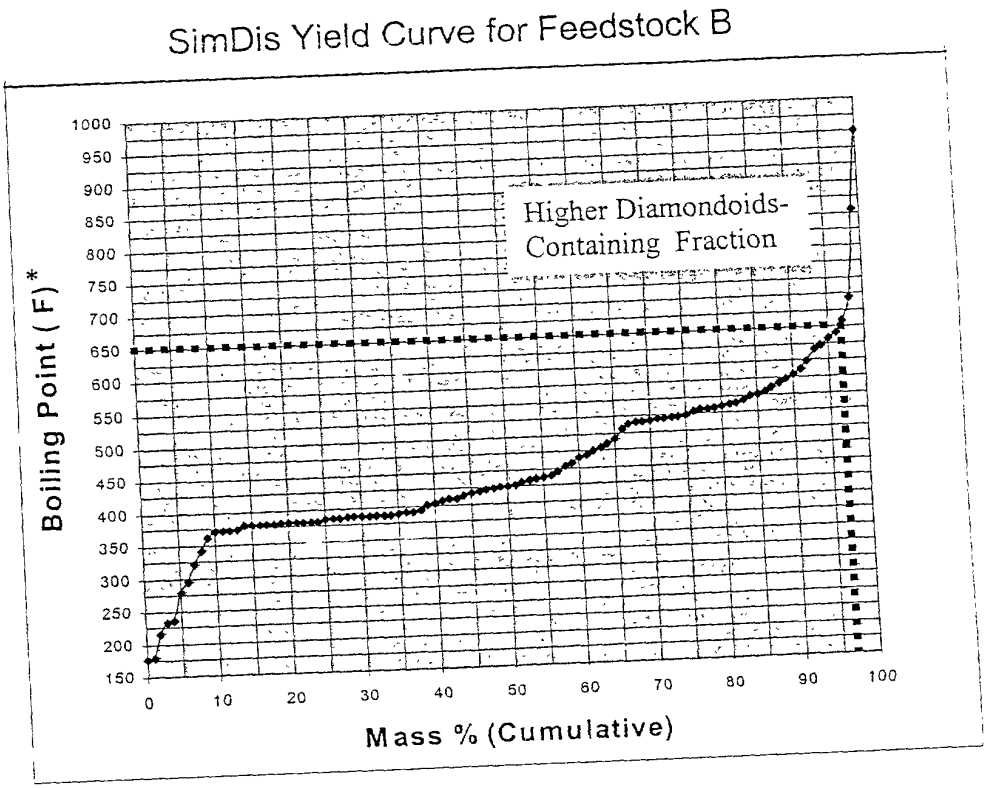


FIG. 3



* Atmospheric-Equivalent

FIG. 4

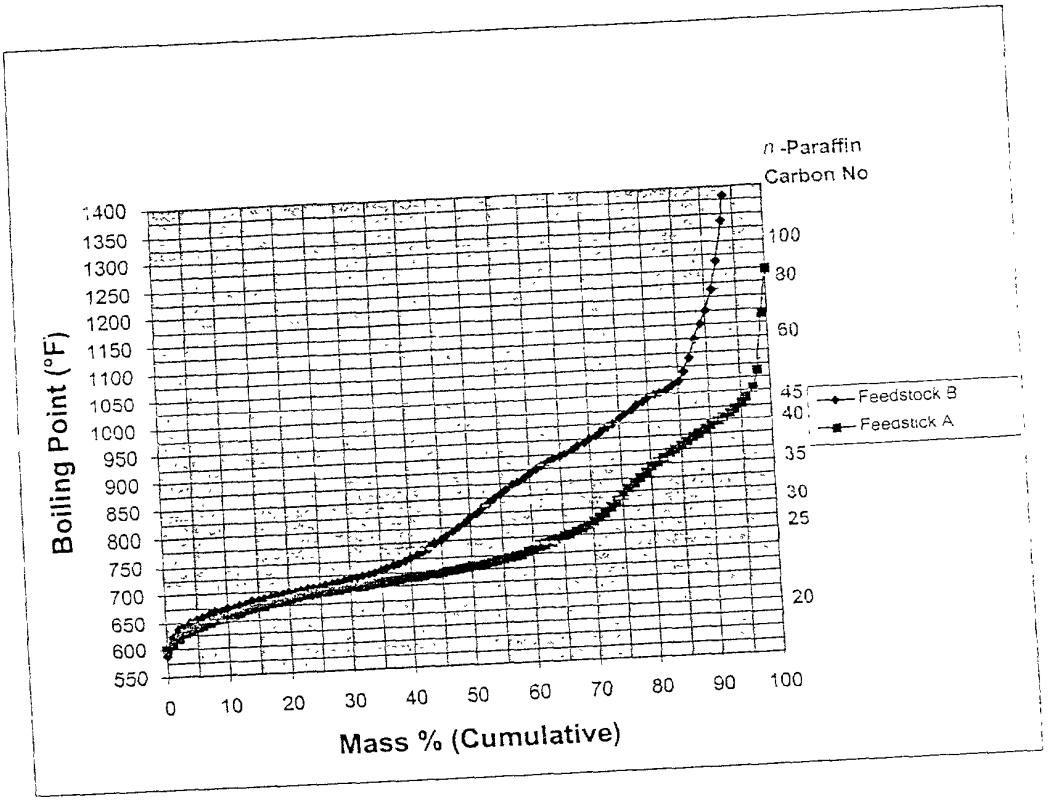

n -Paraffin Carbon No
Boiling Point (°F)
Mass % (Cumulative)
Feedstock B
Feedstick A
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
0
10
20
30
40
50
60
70
80
90
100
100
30
60
45
40
35
30
25
20

FIG. 5

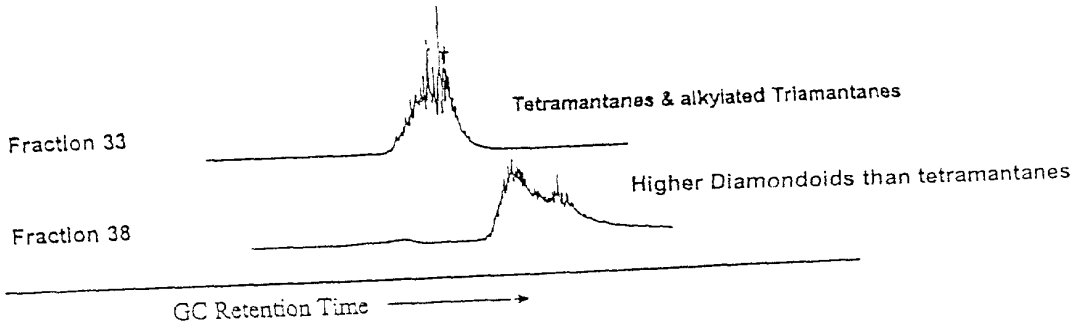

Tetramantanes & alkylated Triamantanes
Fraction 33
Higher Diamondoids than tetramantanes
Fraction 38
GC Retention Time

FIG. 6

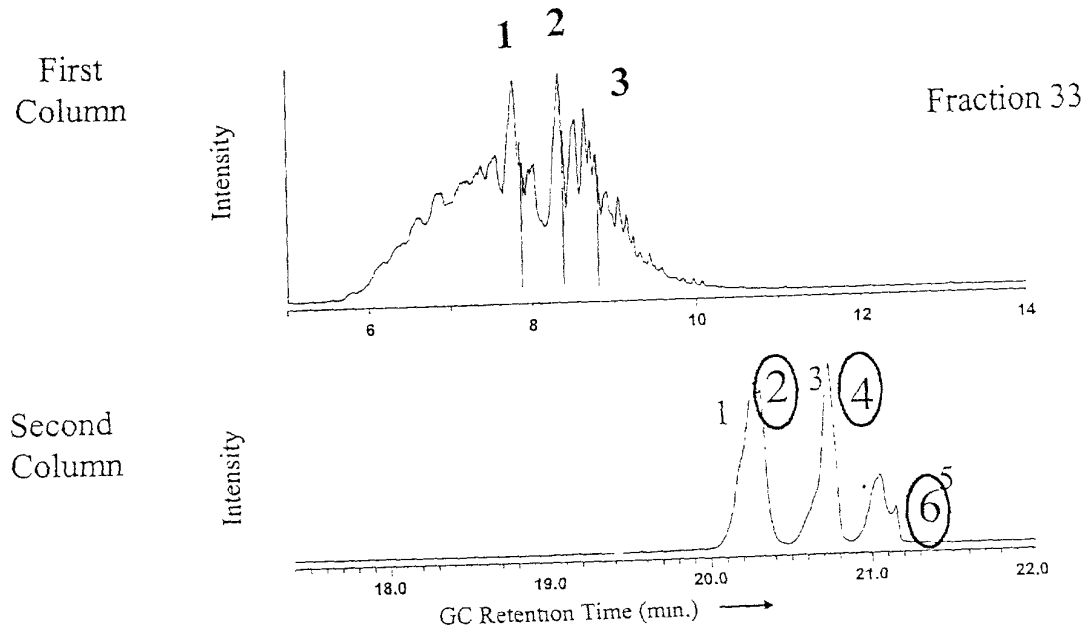

First Column
Second Column
Fraction 33
Intensity
Intensity
1
2
3
1
2
3
4
5
6
6
8
10
12
14
18.0
19.0
20.0
21.0
22.0
GC Retention Time (min.)

FIG. 7

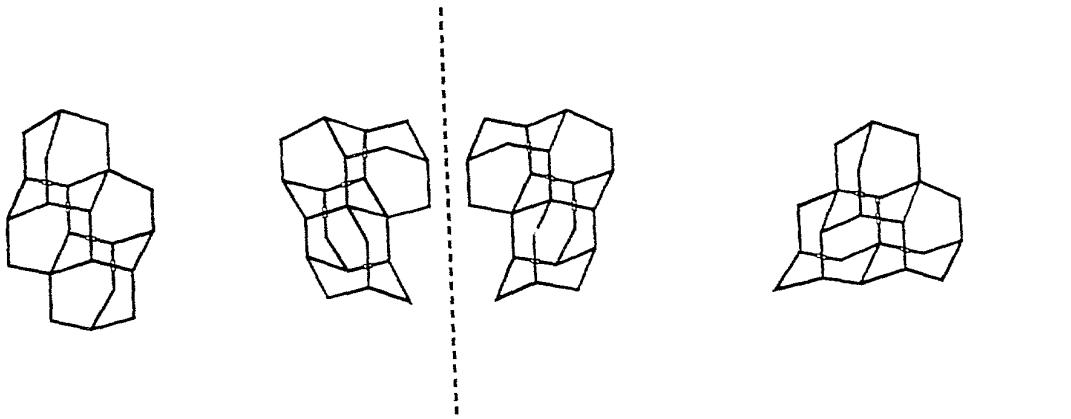

mirror plane
[121] Tetramantane
[123] Tetramantane
(ENANTIOMERS)
[1(2)3] Tetramantane

FIG. 8A

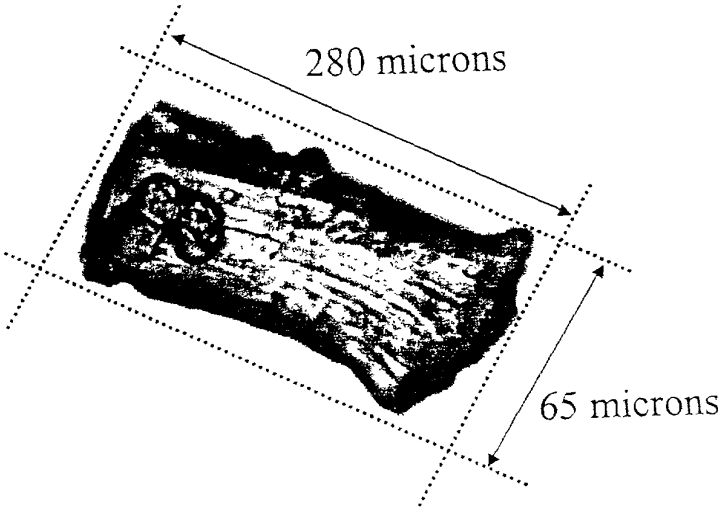


FIG. 8B

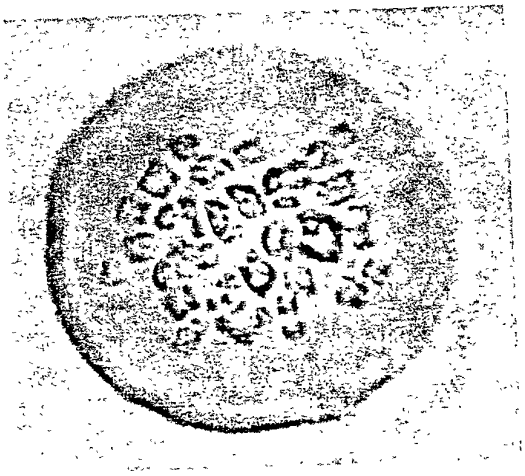


FIG. 8C

FIG. 9

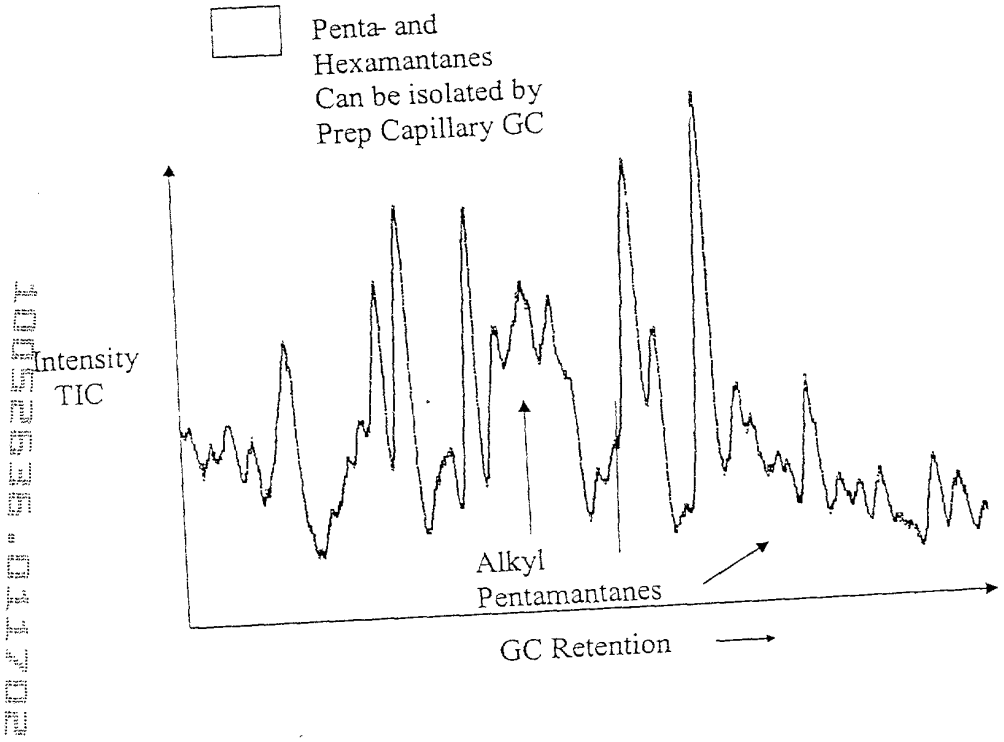

Penta- and
Hexamantanes
Can be isolated by
Prep Capillary GC
Intensity
TIC
Alkyl
Pentamantanes
GC Retention

FIG. 10

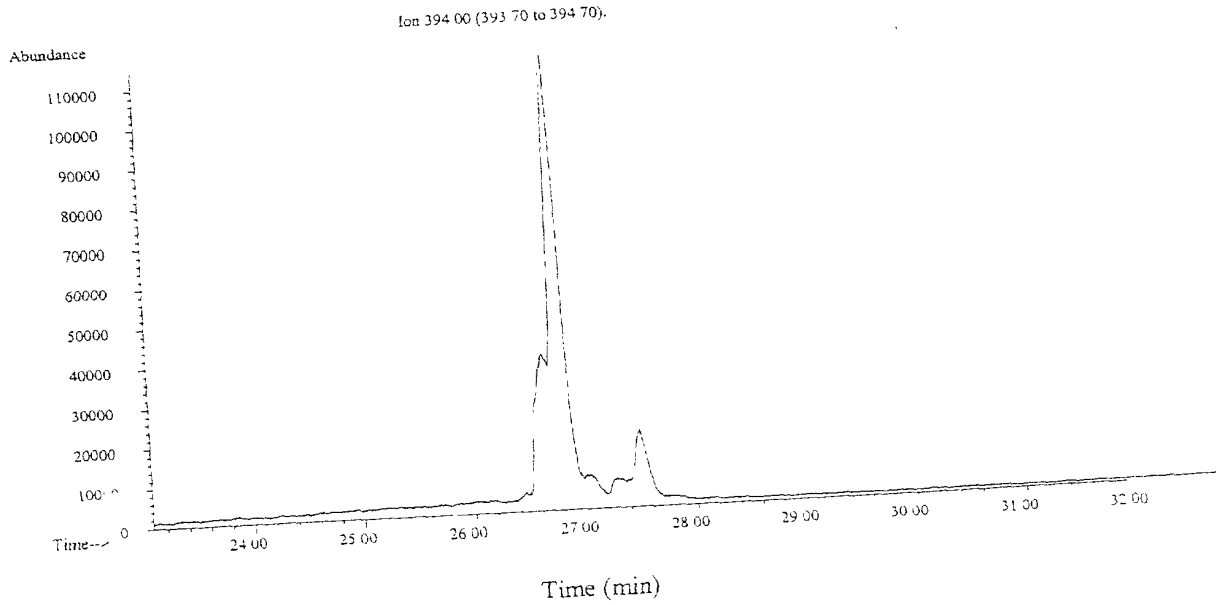

Ion 394.00 (393.70 to 394.70):
Abundance
110000
100000
90000
80000
70000
60000
50000
40000
30000
20000
Time
24.00
25.00
26.00
27.00
28.00
29.00
30.00
31.00
32.00
Time (min)

FIG 11

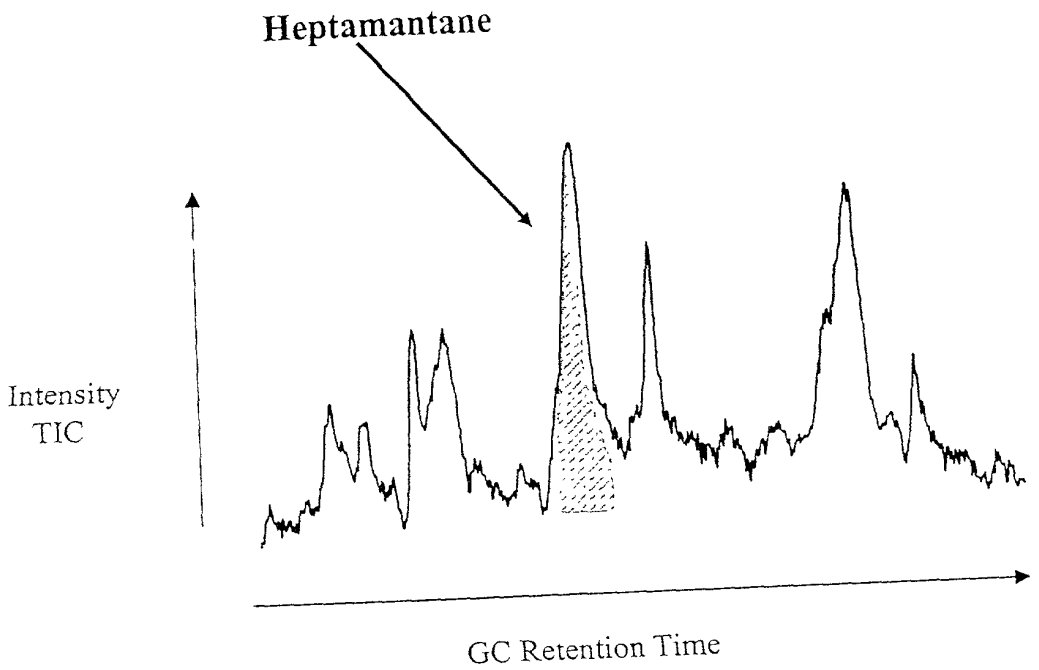


FIG. 12

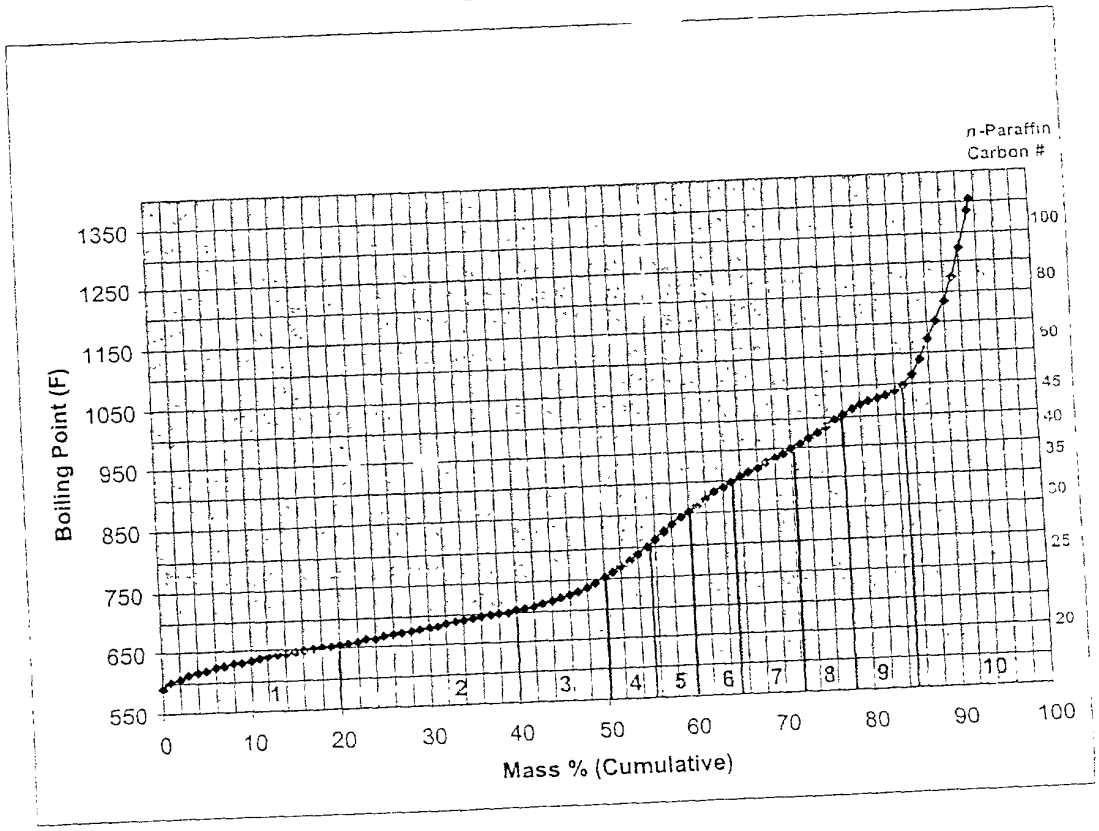


FIG. 13

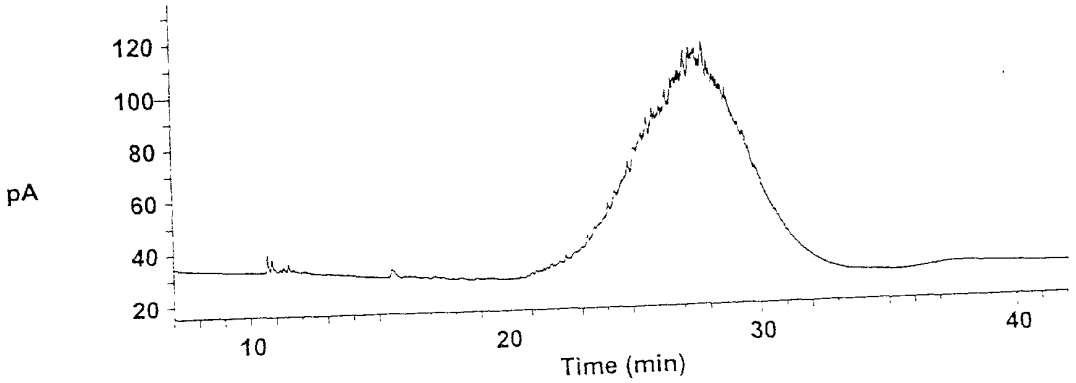

pA
120
100
80
60
40
20
10
20
30
40
Time (min)

FIG. 14

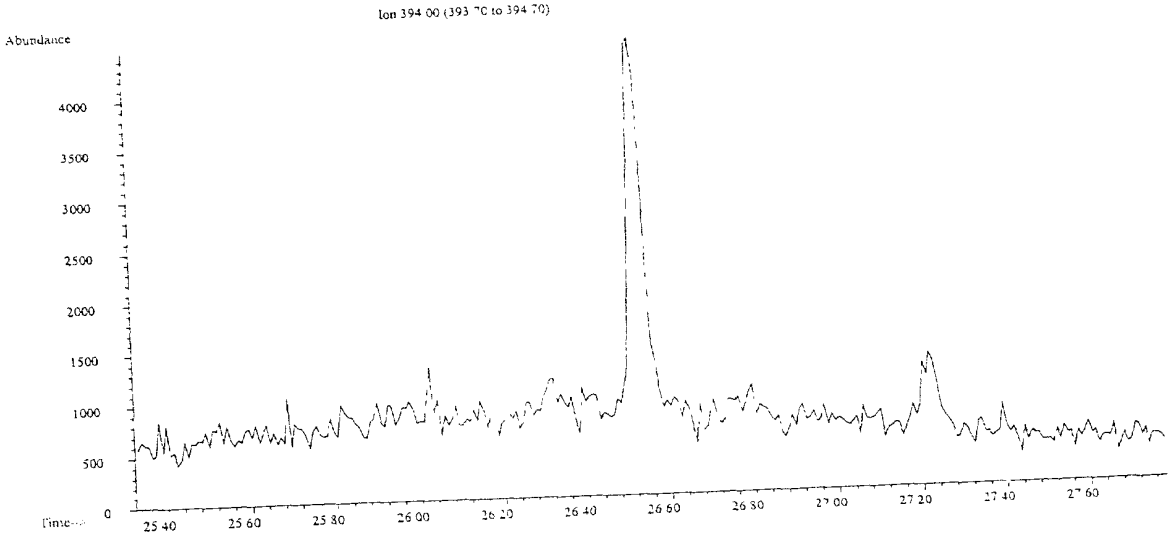

Ion 394.00 (393.70 to 394.70)
Abundance
4000
3500
3000
2500
2000
1500
1000
500
0
25.40
25.60
25.80
26.00
26.20
26.40
26.60
26.80
27.00
27.20
27.40
27.60
Time (min)

FIG. 15

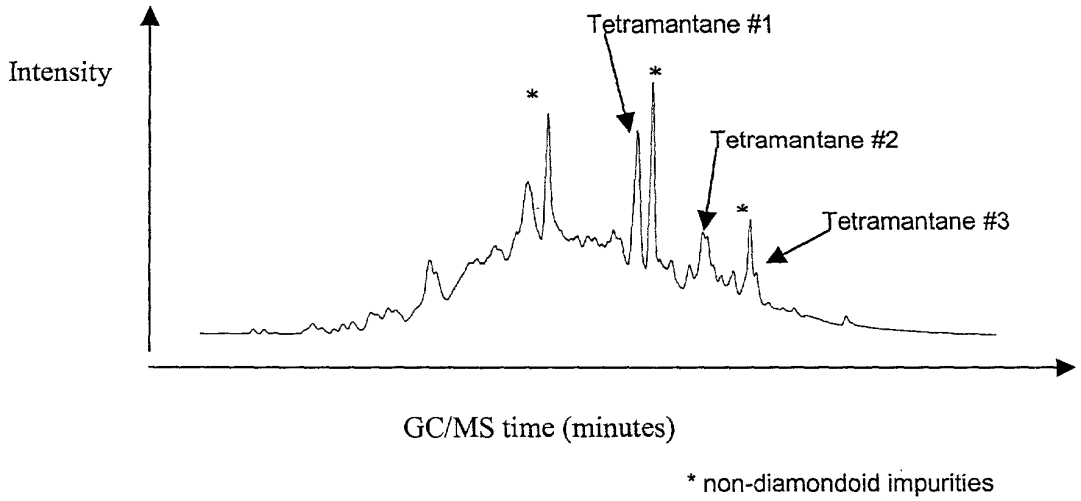

Intensity
Tetramantane #1
Tetramantane #2
Tetramantane #3
*
*
*
GC/MS time (minutes)
* non-diamondoid impurities

FIG. 16

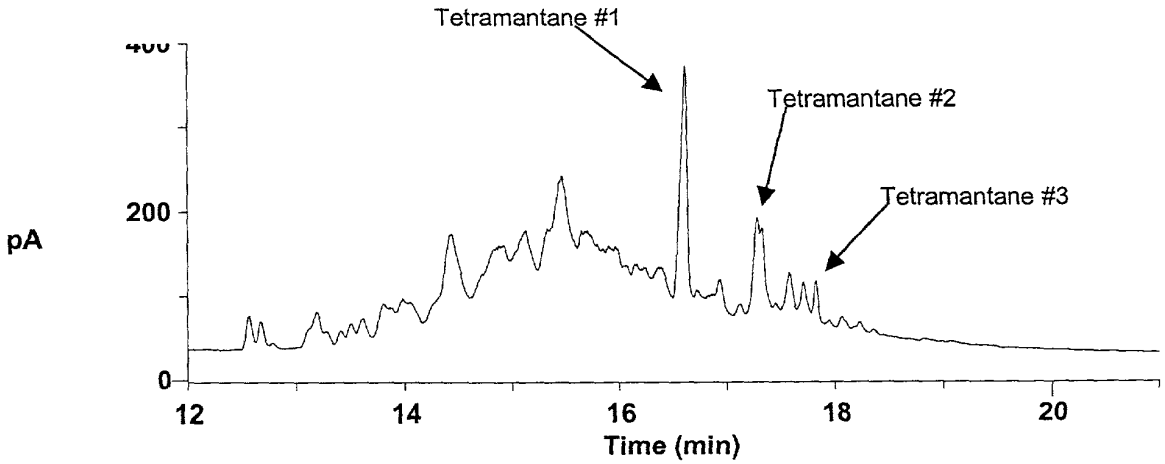

Tetramantane #1
Tetramantane #2
Tetramantane #3
400
200
0
pA
12
14
16
18
20
Time (min)

FIG. 17

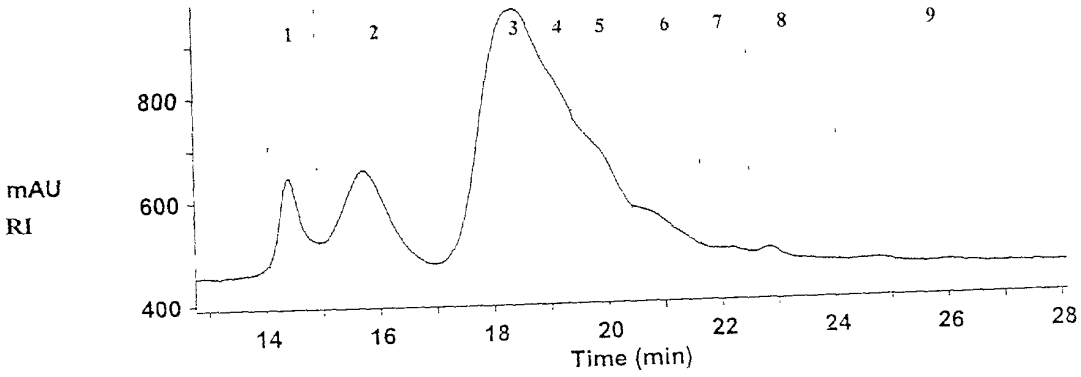

1
2
3
4
5
6
7
8
9
800
600
400
mAU
RI
14
16
18
20
22
24
26
28
Time (min)

FIG. 18

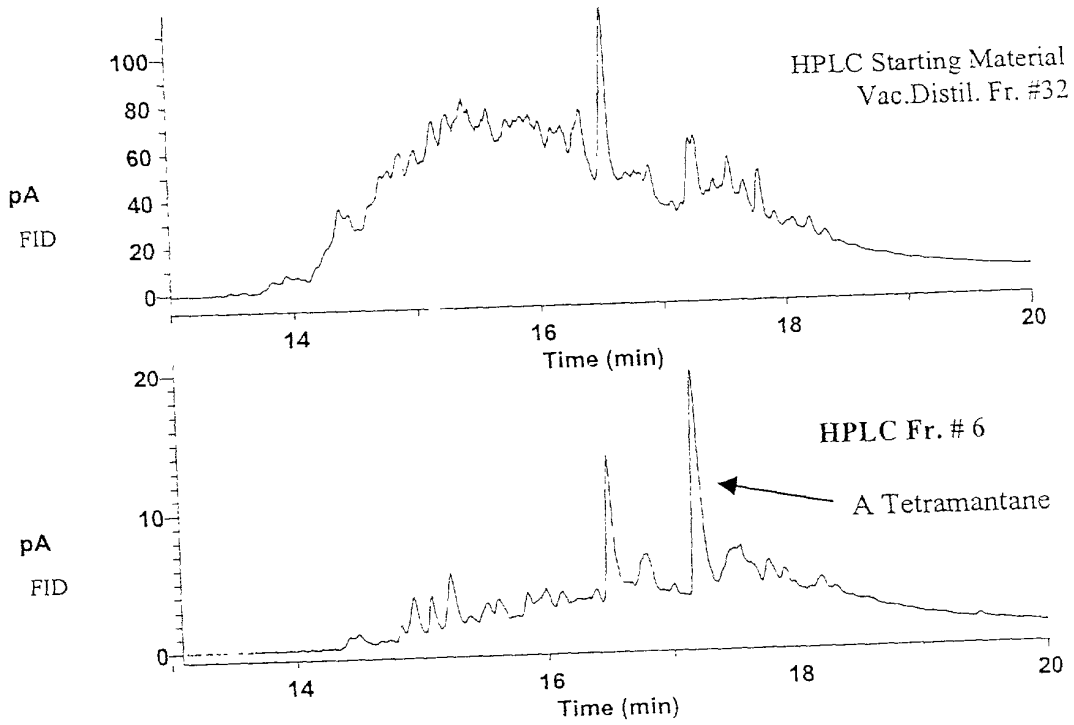

HPLC Starting Material
Vac.Distil. Fr. #32
100
80
60
40
20
0
pA
FID
14
16
18
20
Time (min)
HPLC Fr. # 6
A Tetramantane
20
10
0
pA
FID
14
16
18
20
Time (min)

FIG. 19

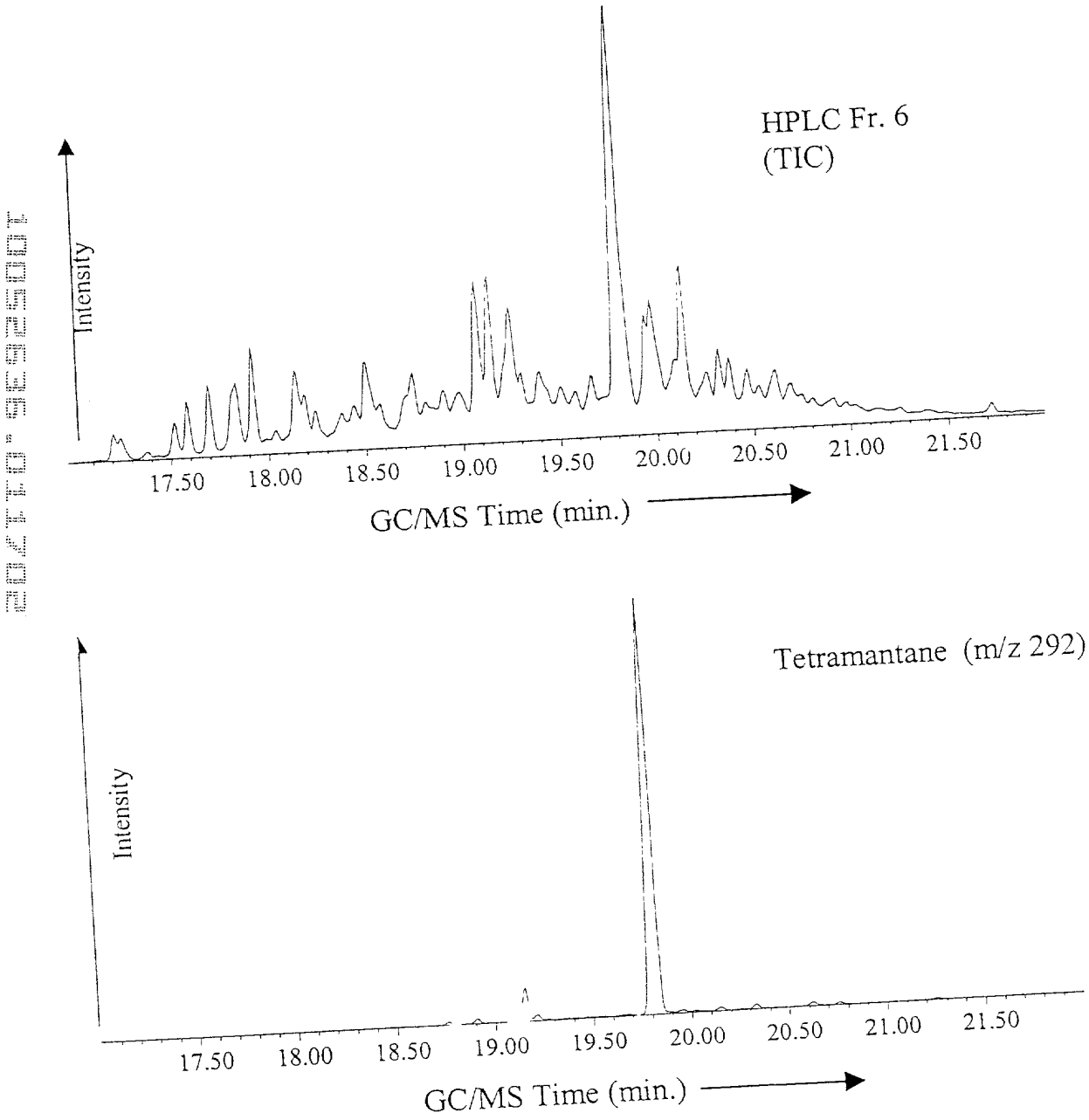

HPLC Fr. 6
(TIC)
Intensity
17.50
18.00
18.50
19.00
19.50
20.00
20.50
21.00
21.50
GC/MS Time (min.)
Tetramantane (m/z 292)
Intensity
17.50
18.00
18.50
19.00
19.50
20.00
20.50
21.00
21.50
GC/MS Time (min.)

FIG. 20

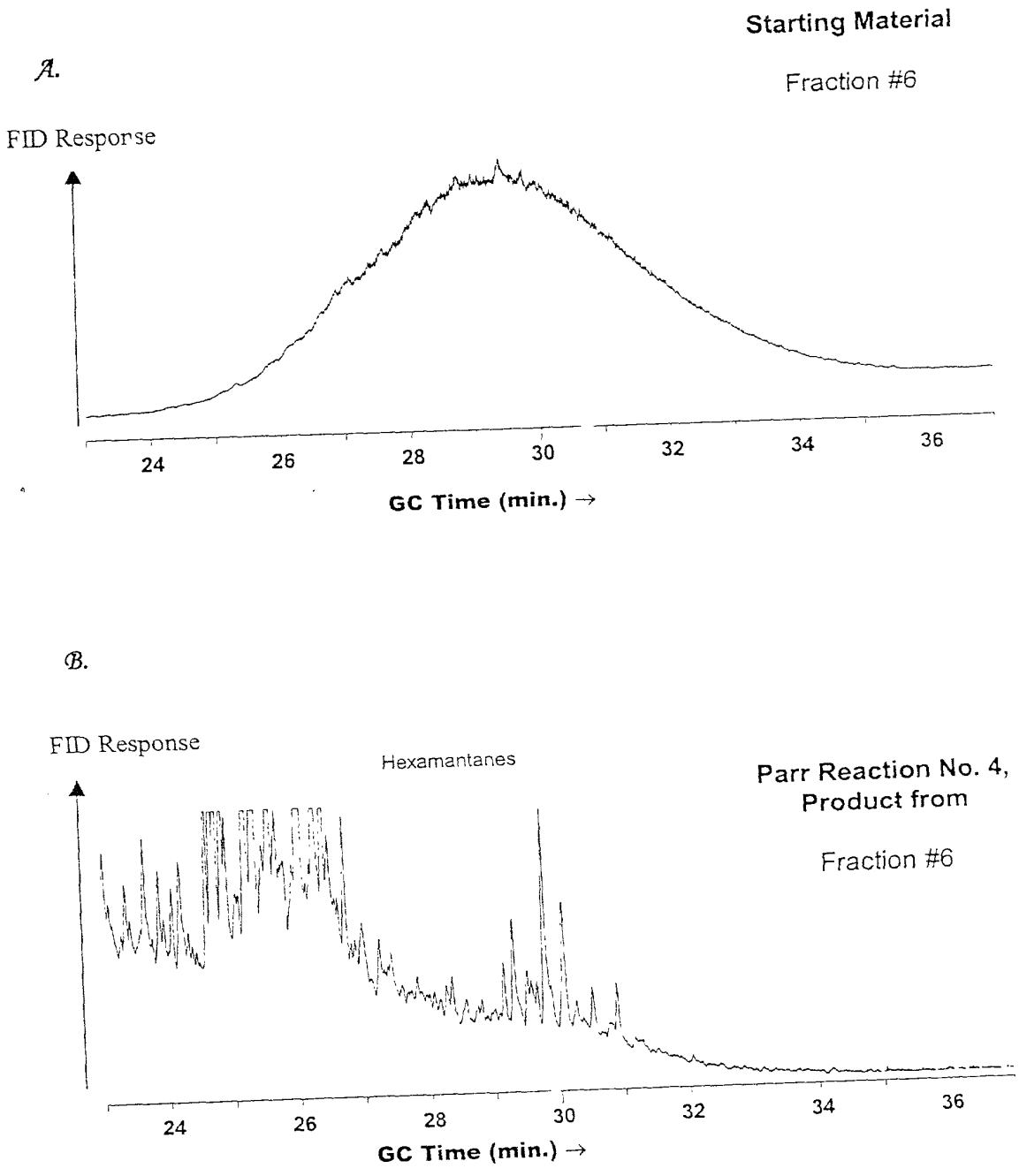

A.
Starting Material
Fraction #6
FID Response
24
26
28
30
32
34
36
GC Time (min.) →
B.
FID Response
Hexamantanes
Parr Reaction No. 4, Product from
Fraction #6
24
26
28
30
32
34
36
GC Time (min.) →

FIG. 21

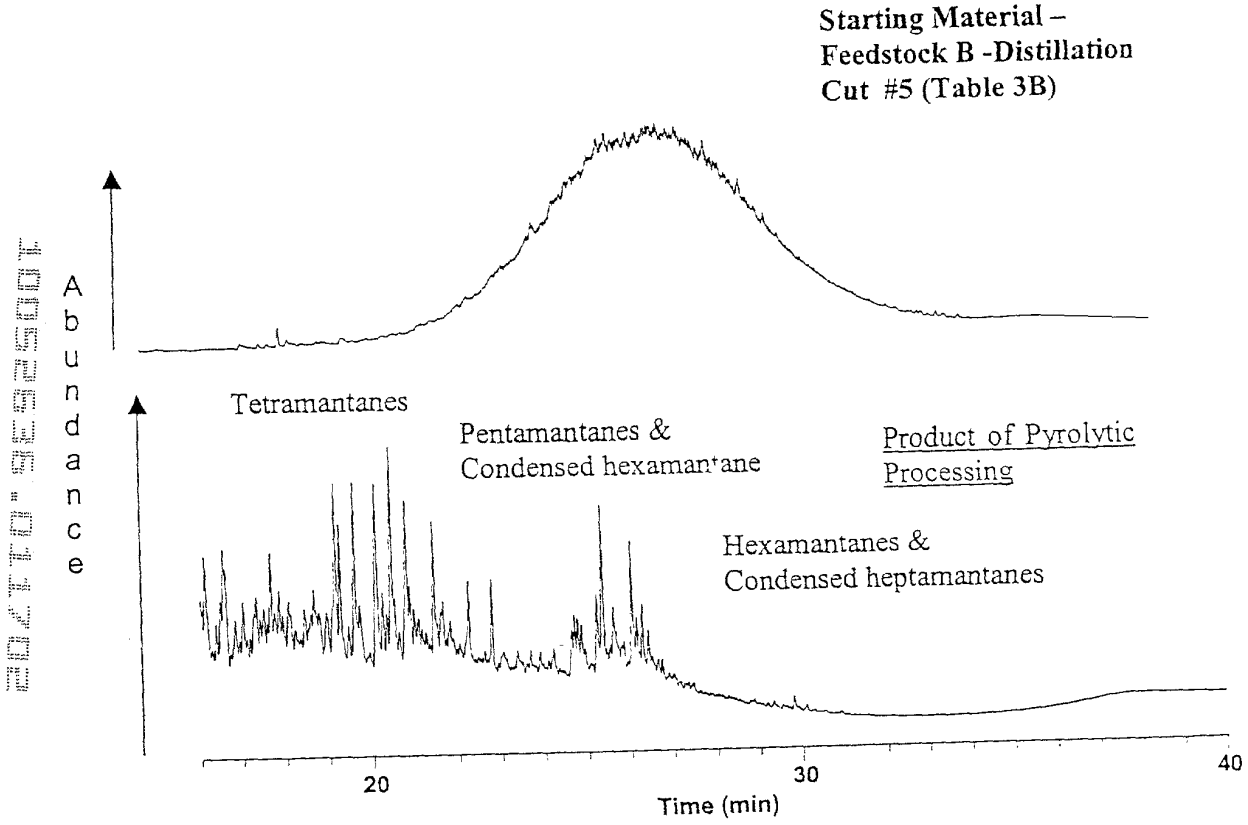

Starting Material –
Feedstock B -Distillation
Cut #5 (Table 3B)
Abundance
Tetramantanes
Pentamantanes &
Condensed hexamantane
Product of Pyrolytic
Processing
Hexamantanes &
Condensed heptamantanes
20
30
40
Time (min)

FIG. 22

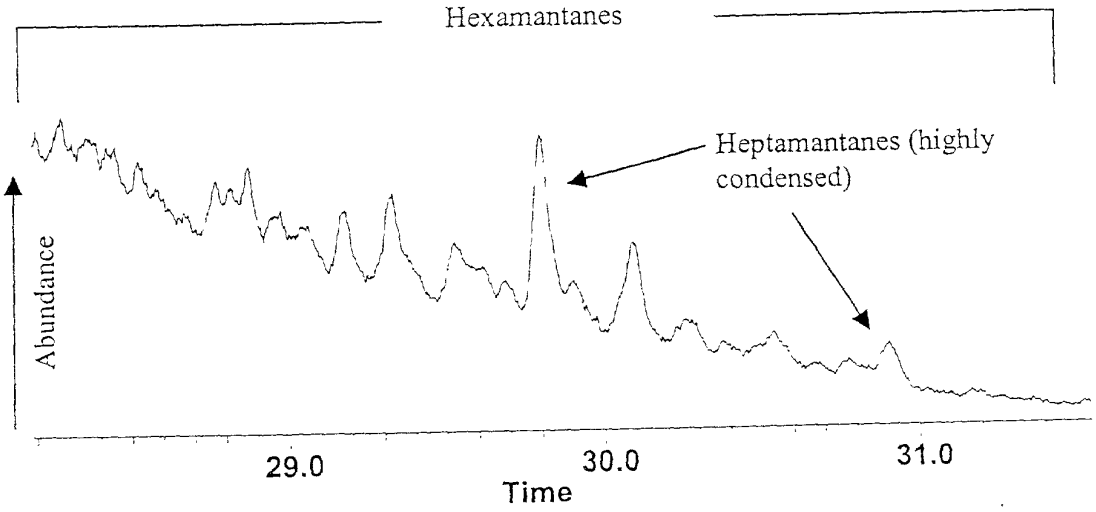

Hexamantanes
Heptamantanes (highly condensed)
Abundance
29.0
30.0
31.0
Time

FIG. 23

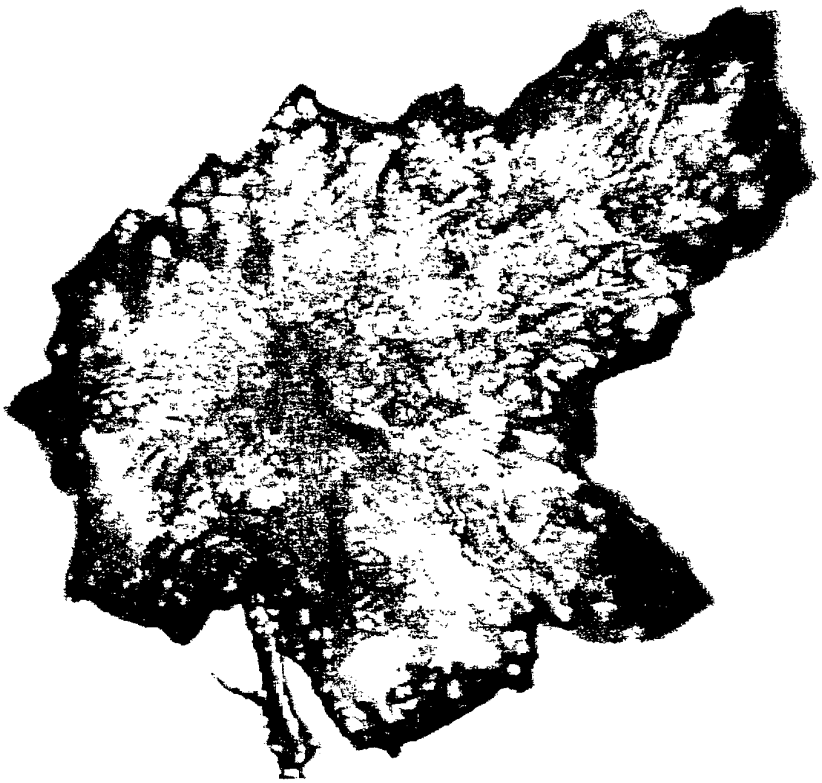
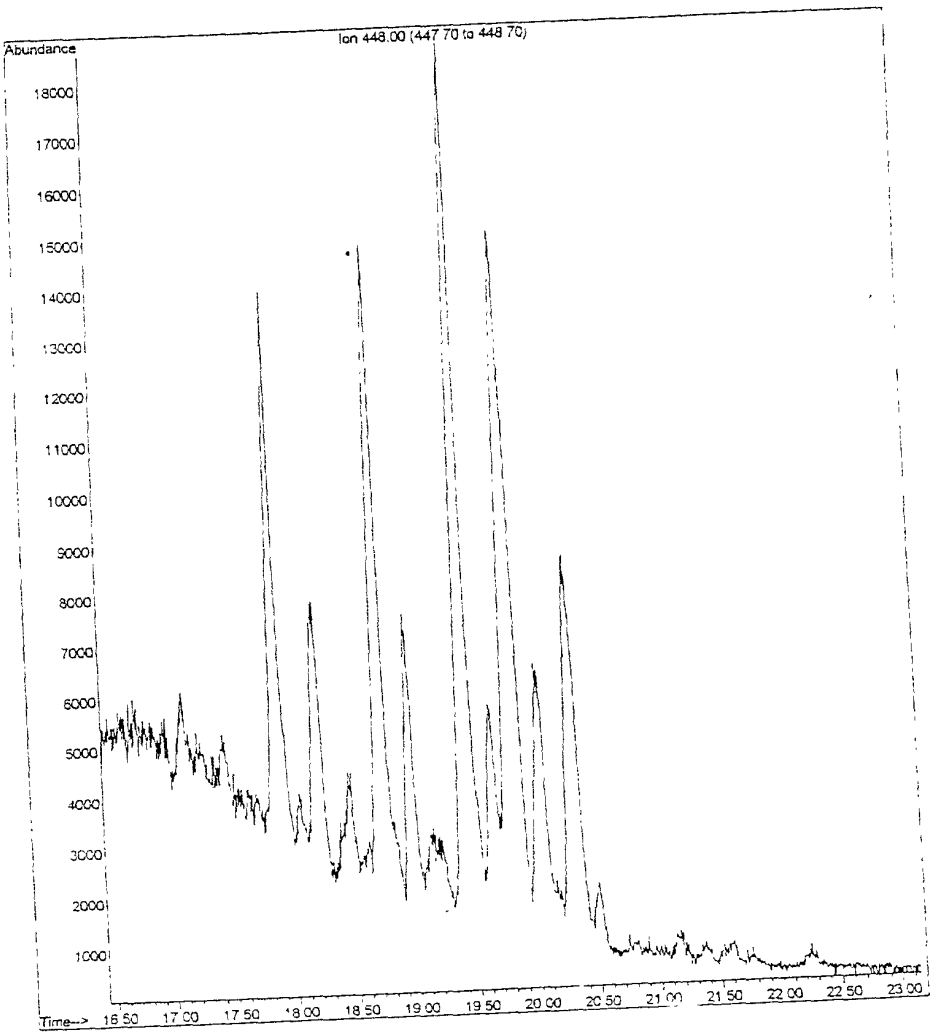
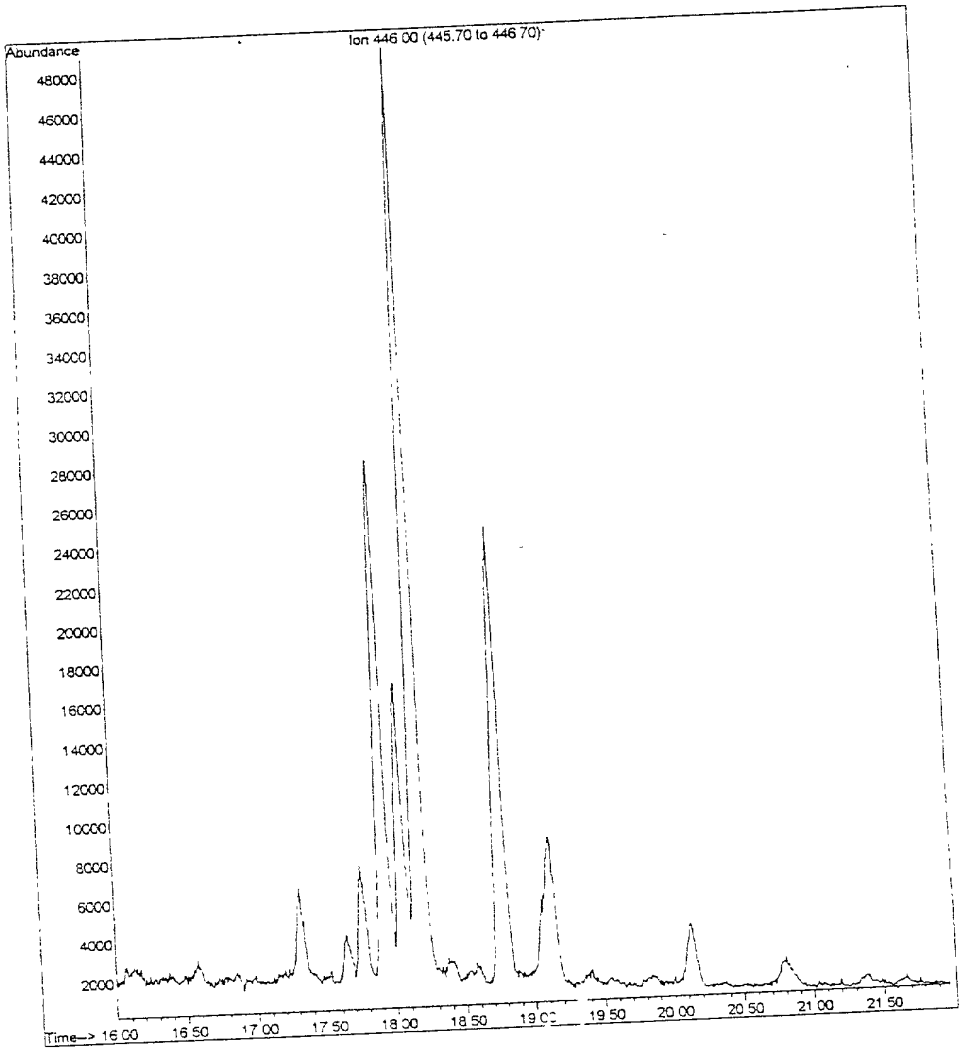


FIG. 24



Time (min)

FIG. 25



Time (min)

FIG. 26

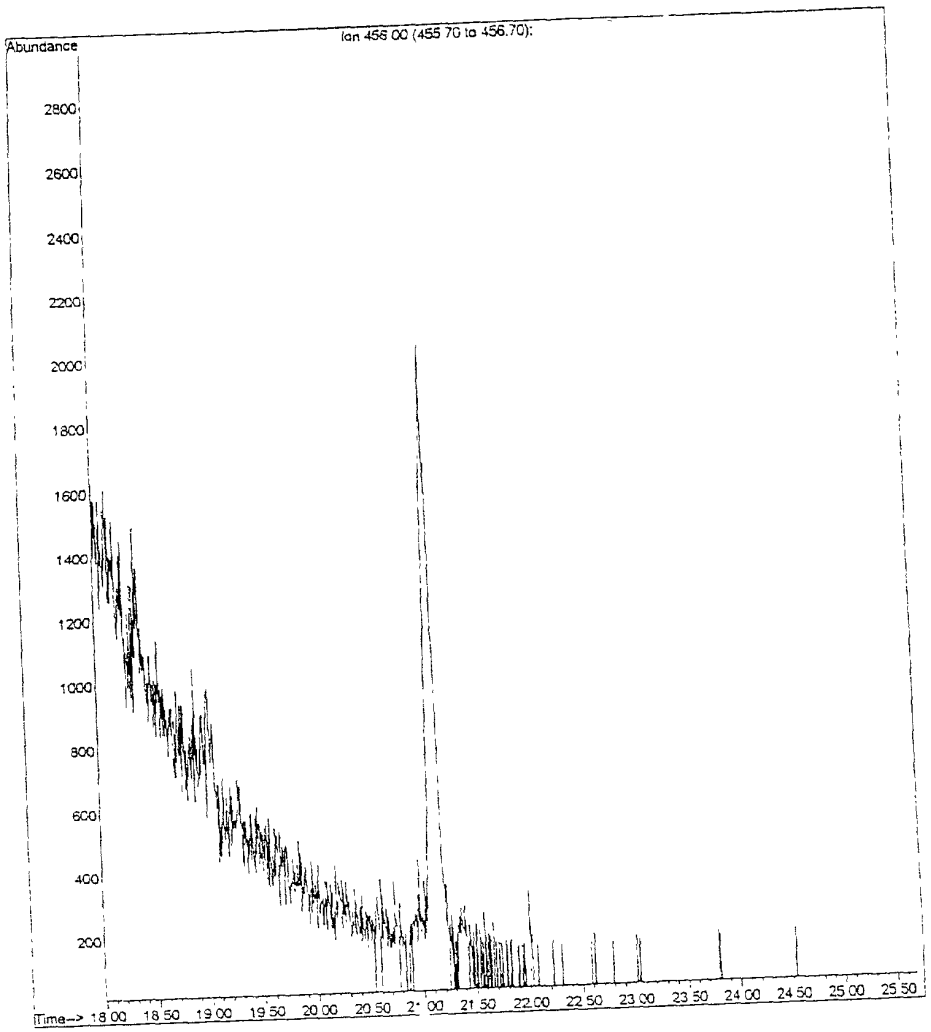
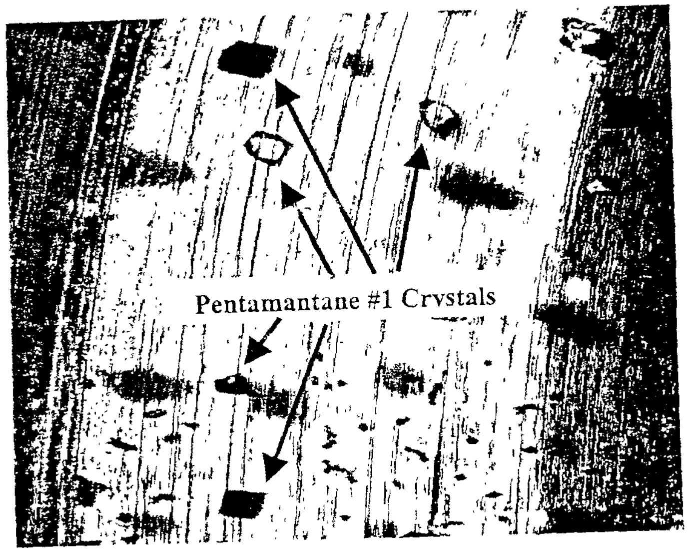
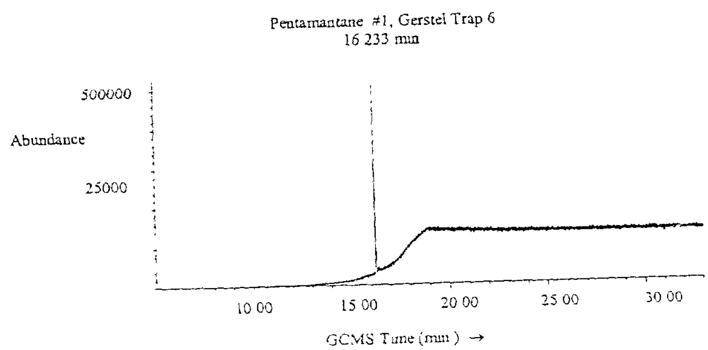


FIG. 27

A.



B.



C.

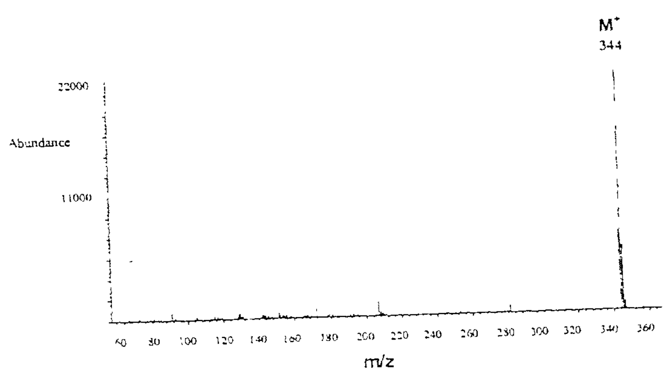
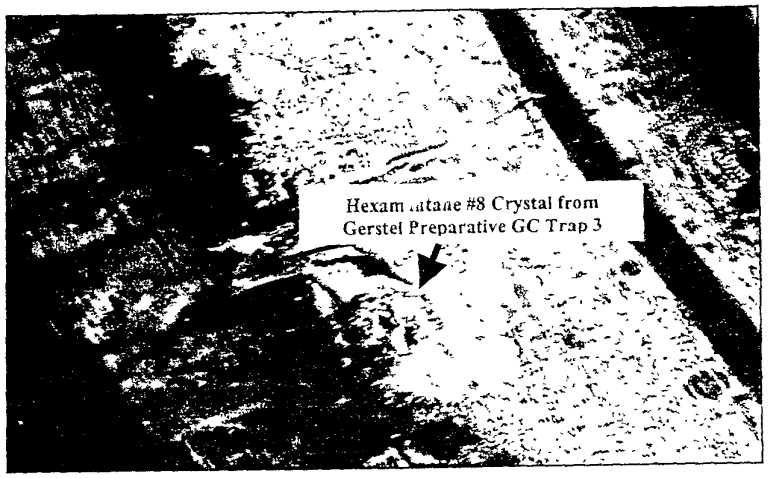
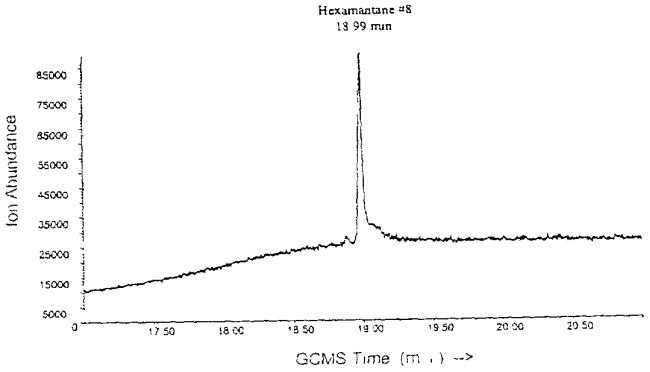


FIG. 28

A.


Hexamantane #8 Crystal from
Gerstel Preparative GC Trap 3

B.


Hexamantane #8
18.99 min
Ion Abundance
85000
75000
65000
55000
45000
35000
25000
15000
5000
0
17.50
18.00
18.50
19.00
19.50
20.00
20.50
GCMS Time (m .) -->

C.

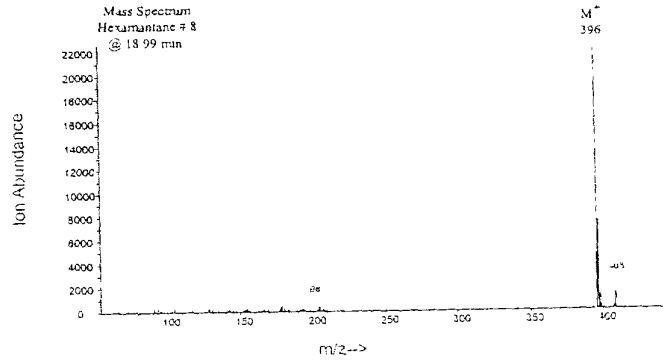
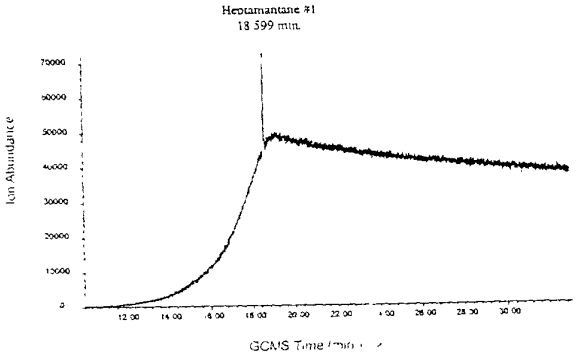

Mass Spectrum
Hexamantane # 8
@ 18.99 min
M+
396
Ion Abundance
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
100
150
200
250
300
350
400
m/z-->

FIG. 29

A.

Heptamantane #1 Crystals

B.



C.

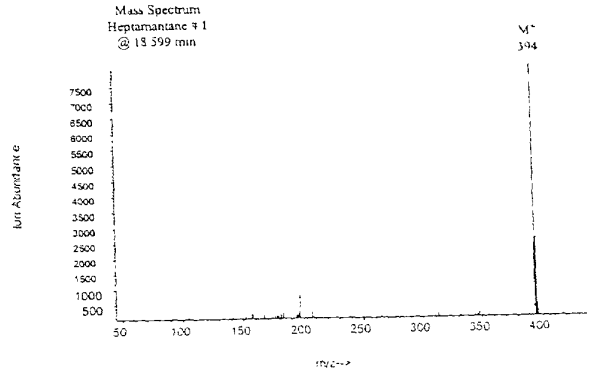


FIG. 30

Number of Diamond Crystal Cage Units	Number of Molecular Formulae	Higher Diamondoid	Molecular Weights							
4	1	Tetramantane	292							
5	2	Pentamantane	344	330						
6	3	Hexamantane	396	382	342					
7	4	Heptamantane	448	434	394	420				
8	5	Octamantane	500	486	446	420	432			
9	6	Nonamantane	552	538	498	524	484	444		
10	7	Decamantane	604	590	550	576	536	496	456	
11	8	Undecamantane	656	642	602	628	588	548	508	534

FIG. 31

Distillation Cuts Made on Atmospheric Resid of Feedstock B (°F)

Higher Diamondoid	601-656 Fr.1	656-702 Fr.2	702-752 Fr.3	752-800 Fr.4	800-852 Fr.5	852-900 Fr.6	900-950 Fr.7	950-976 Fr. 8	976-1000 Fr. 9	1000-1026 Fr.10
Tetramantanes										
Pentamantanes										
Cyclohexamantanes										
Hexamantanes										
Heptamantanes										
Octamantanes										
Nonamantanes										
Decamantanes										
Undecamantanes										

FIG. 32

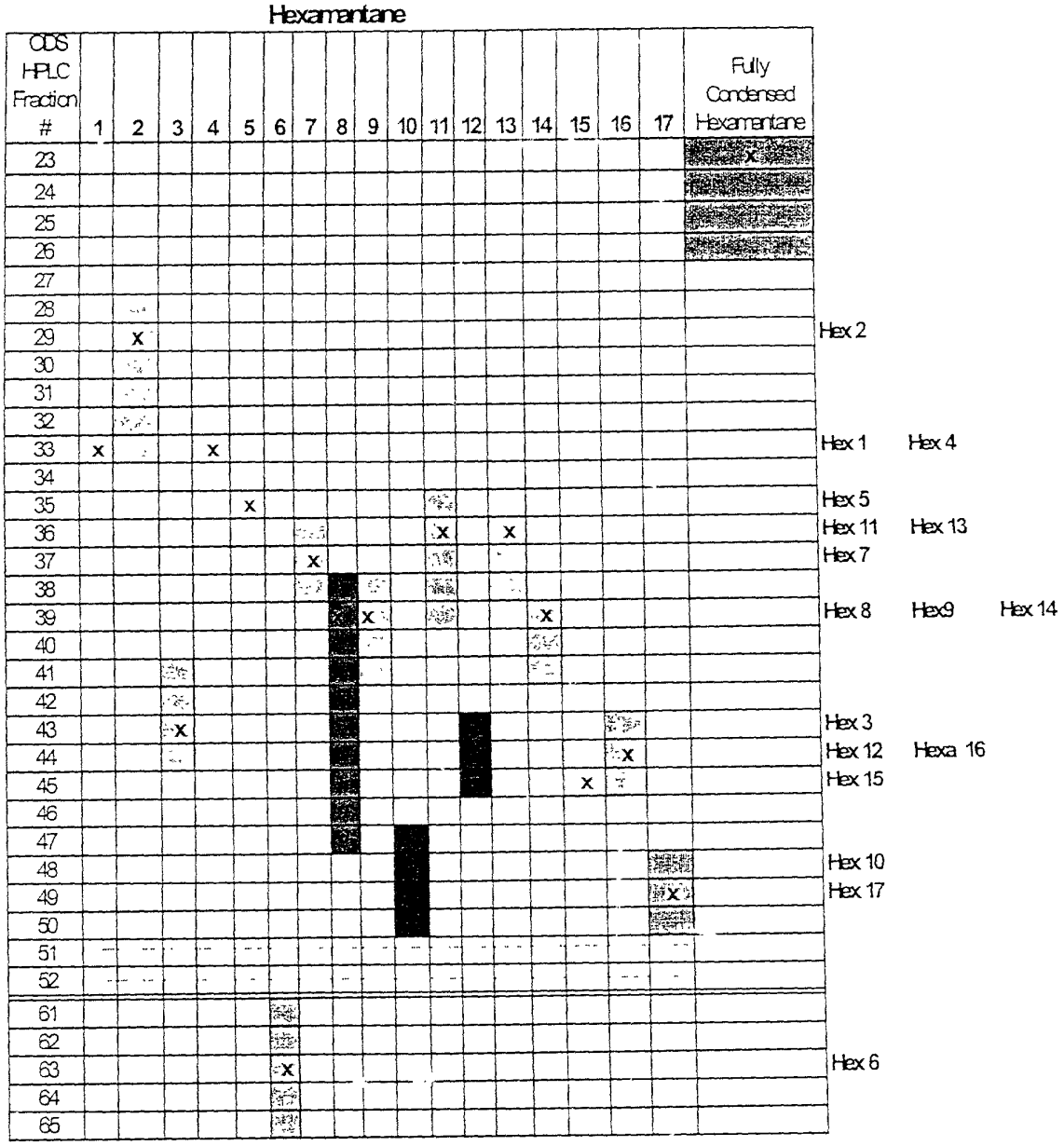


FIG. 33

Hypercarb HPLC Fraction #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Fully Condensed Hexamantane	
1																			
2																			
3																		x	
4																			
5																			
26																			Hex 13
27													x						
28														x					Hex 14
29																			Hex 1
30	x																		Hex 10
31																			Hex 11
32																			
33											x								
34																			
35																			
43																			Hex 6
44						x													
45																			
46																			
47																			
48																x			Hex 15
49																			Hex 9
50									x										
51																			
52																			
53																			Hex 2
54		x																	
55																			
56																			
57																			
58																			
59																			
60																			
61																			
62																			
72																			
73																			
74								x											Hex 7
75																			
76																			
77																			
78																			
84																			

FIG. 34

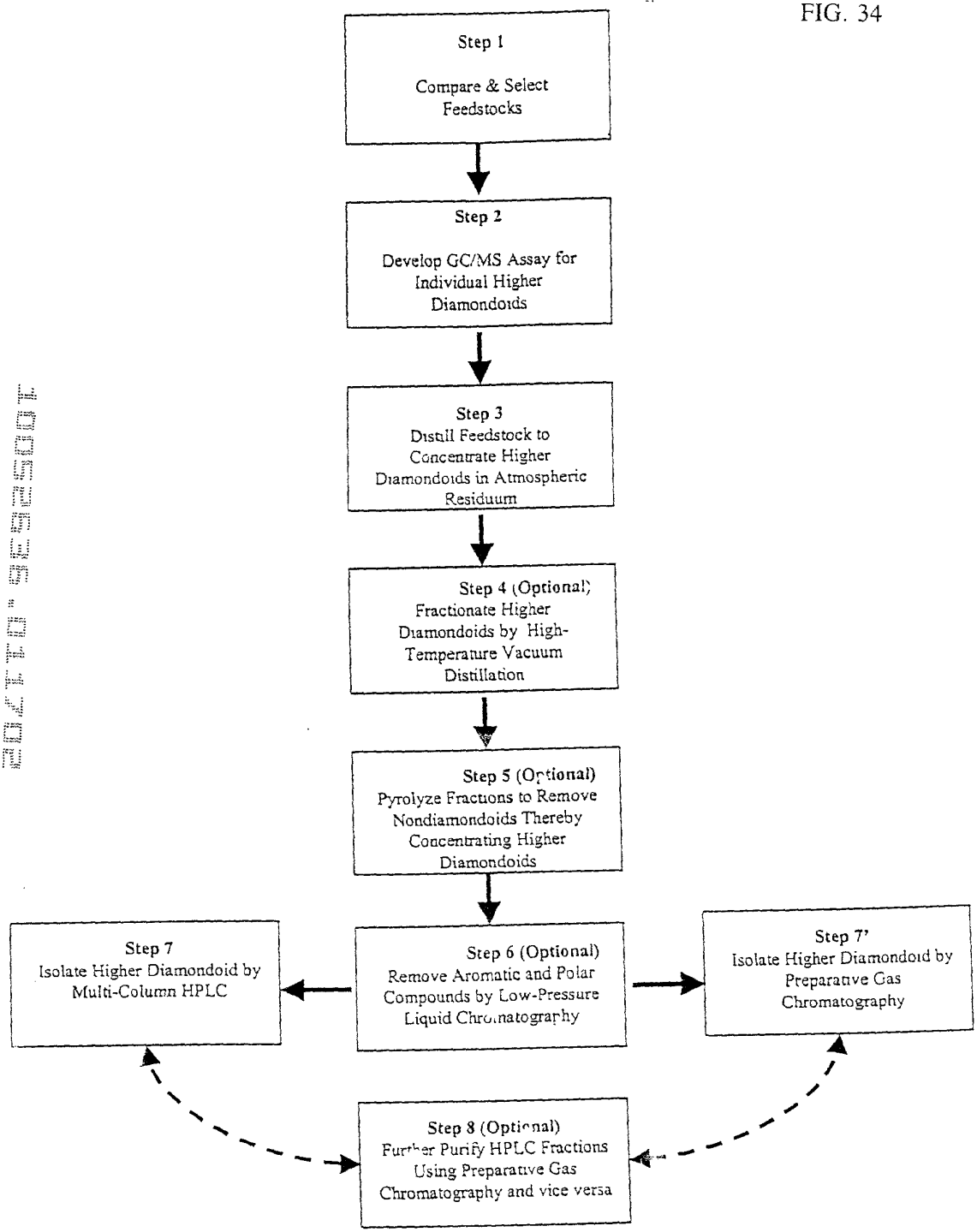

Step 1
Compare & Select Feedstocks
Step 2
Develop GC/MS Assay for Individual Higher Diamondoids
Step 3
Distill Feedstock to Concentrate Higher Diamondoids in Atmospheric Residuum
Step 4 (Optional)
Fractionate Higher Diamondoids by High-Temperature Vacuum Distillation
Step 5 (Optional)
Pyrolyze Fractions to Remove Nondiamondoids Thereby Concentrating Higher Diamondoids
Step 6 (Optional)
Remove Aromatic and Polar Compounds by Low-Pressure Liquid Chromatography
Step 7
Isolate Higher Diamondoid by Multi-Column HPLC
Step 7'
Isolate Higher Diamondoid by Preparative Gas Chromatography
Step 8 (Optional)
Further Purify HPLC Fractions Using Preparative Gas Chromatography and vice versa

FIG. 35A

Higher Diamondoid	Compound Reference Number	M+ (m/z) (Equals Base Peak)	GC/MS Retention Times* (min.)	GC/MS Relative Retention Times** (min.)
Tetramantane #1	4-1	292	8.10	1.00
Tetramantane #2	4-2	292	8.66	1.07
Tetramantane #3	4-3	292	9.12	1.13
Pentamantane #1	5-1	344	10.40	1.28
Pentamantane #2	5-2	344	11.93	1.47
Pentamantane #3	5-3	344	11.98	1.48
Pentamantane #4	5-4	344	12.38	1.53
Pentamantane #5	5-5	344	12.50	1.54
Pentamantane #6	5-6	344	12.71	1.57
Cyclohexamantane	C-6	342	12.34	1.52
Hexamantane #1	6-1	396	14.46	1.78
Hexamantane #2	6-2	396	14.61	1.80
Hexamantane #3	6-3	396	14.97	1.85
Hexamantane #4	6-4	396	14.99	1.85
Hexamantane #5	6-5	396	15.04	1.86
Hexamantane #6	6-6	396	15.13	1.87
Hexamantane #7	6-7	396	15.22	1.88
Hexamantane #8	6-8	396	15.32	1.89
Hexamantane #9	6-9	396	15.42	1.90
Hexamantane #10	6-10	396	15.45	1.91
Hexamantane #11	6-11	396	15.49	1.91
Hexamantane #12	6-12	396	15.54	1.92
Hexamantane #13	6-13	396	15.60	1.93
Hexamantane #14	6-14	396	15.81	1.95
Hexamantane #15	6-15	396	15.89	1.96
Hexamantane #16	6-16	396	16.05	1.98
Hexamantane #17	6-17	396	16.08	1.99
Heptamantane #1	7-1	394	14.96	1.85
Heptamantane #2	7-2	394	15.53	1.92
Heptamantane #3	7-3	448	17.34	2.14
Heptamantane #4A	7-4A	448	17.70	2.18
Heptamantane #4B	7-4B	448	17.70	2.18
Heptamantane #5	7-5	448	17.71	2.19
Heptamantane #6	7-6	448	17.79	2.20
Heptamantane #7	7-7	448	17.82	2.20
Heptamantane #8	7-8	448	17.99	2.22
Heptamantane #9A	7-9A	448	18.13	2.24
Heptamantane #9B	7-9B	448	18.13	2.24
Heptamantane #9C	7-9C	448	18.13	2.24
Heptamantane #10	7-10	448	18.15	2.24
Heptamantane #11	7-11	448	18.20	2.25
Heptamantane #12	7-12	448	18.21	2.25
Heptamantane #13A	7-13A	448	18.29	2.26
Heptamantane #13B	7-13B	448	18.29	2.26
Heptamantane #13C	7-13C	448	18.29	2.26
Heptamantane #14	7-14	448	18.32	2.26

FIG. 35A cont'd

Higher Diamondoid	Compound Reference Number	M+ (m/z) (Equals Base Peak)	GC/MS Retention Times* (min.)	GC/MS Relative Retention Times** (min.)
Octamantane #1	8-1	446	17.30	2.14
Octamantane #2	8-2	446	17.37	2.14
Octamantane #3	8-3	446	17.42	2.15
Octamantane #4	8-4	446	17.47	2.16
Octamantane #5	8-5	446	17.71	2.19
Octamantane #6	8-6	446	17.82	2.20
Octamantane #7	8-7	446	17.86	2.20
Octamantane #8	8-8	446	18.22	2.25
Octamantane #9	8-9	446	18.46	2.28
Octamantane #10	8-10	446	18.65	2.30
Octamantane #11	8-11	446	18.76	2.32
Nonamantane #1	9-1	498	19.86	2.45
Decamantane #1	10-1	456	18.57	2.29
Decamantane #2	10-2	496	21.33	2.63
Undecamantane#1	11-1	508	21.05	2.60

* HP-MS5 (30m X 0.25 mm, 0.25 micron film), helium carrier gas,
** Reference to Tetramantane #1

FIG. 35B

Higher Diamondoid	Compound Reference Number	Fraction Number	Elution Time (min.)	Elution Volume (mL)	Elution Volume Relative to 4-1
Tetramantane #1	4-1	4	119	594	1.00
Tetramantane #2	4-2	7	125	627	1.05
Tetramantane #3	4-3	6	123	616	1.04
Pentamantane #1	5-1	11	134	669	1.13
Pentamantane #2	5-2	19	151	754	1.27
Pentamantane #3	5-3	28	170	850	1.43
Pentamantane #4	5-4	22	157	786	1.32
Pentamantane #5	5-5	19	151	754	1.27
Pentamantane #6	5-6	20	153	765	1.29
Cyclohexamantane	C-6	23	159	797	1.34
Hexamantane #1	6-1	33	181	903	1.52
Hexamantane #2	6-2	29	172	861	1.45
Hexamantane #3	6-3	43	202	1012	1.70
Hexamantane #4	6-4	33	181	903	1.52
Hexamantane #5	6-5	35	185	924	1.56
Hexamantane #6	6-6	63	242	1211	2.04
Hexamantane #7	6-7	37	189	945	1.59
Hexamantane #8	6-8	39	193	967	1.63
Hexamantane #9	6-9	39	193	967	1.63
Hexamantane #10	6-10	48	214	1071	1.80
Hexamantane #11	6-11	36	187	935	1.57
Hexamantane #12	6-12	44	205	1024	1.72
Hexamantane #13	6-13	36	187	935	1.57
Hexamantane #14	6-14	39	193	967	1.63
Hexamantane #15	6-15	45	207	1036	1.74
Hexamantane #16	6-16	44	205	1024	1.72
Hexamantane #17	6-17	49	217	1083	1.82
Heptamantane #1	7-1	45	207	1036	1.74
Heptamantane #2	7-2	41	198	989	1.66
Heptamantane #3	7-3	61	238	1190	2.00
Heptamantane #4A	7-4A	90	304	1519	2.56
Heptamantane #4B	7-4B	90	304	1519	2.56
Heptamantane #5	7-5	76	270	1349	2.27
Heptamantane #6	7-6	67	251	1253	2.11
Heptamantane #7	7-7	—	—	—	—
Heptamantane #8	7-8	59	234	1172	1.97
Heptamantane #9A	7-9A	60	236	1181	1.99
Heptamantane #9B	7-9B	62	240	1200	2.02
Heptamantane #9C	7-9C	78	274	1370	2.31
Heptamantane #10	7-10	86	291	1455	2.45
Heptamantane #11	7-11	—	—	—	—
Heptamantane #12	7-12	—	—	—	—
Heptamantane #13A	7-13A	58	233	1163	1.96
Heptamantane #13B	7-13B	74	266	1328	2.24
Heptamantane #13C	7-13C	90	304	1519	2.56
Heptamantane #14	7-14	70	257	1285	2.16

FIG. 35B cont'd

Higher Diamondoid	Compound Reference Number	Fraction Number	Elution Time (min.)	Elution Volume (mL)	Elution Volume Relative to 4-1
Octamantane #1	8-1	81	280	1402	2.36
Octamantane #2	8-2	83	285	1423	2.40
Octamantane #3	8-3	64	244	1221	2.06
Octamantane #4	8-4	—	—	—	—
Octamantane #5	8-5	63	242	1211	2.04
Octamantane #6	8-6	79	276	1381	2.32
Octamantane #7	8-7	71	259	1296	2.18
Octamantane #8	8-8	84	287	1434	2.41
Octamantane #9	8-9	74	266	1328	2.24
Octamantane #10	8-10	80	280	1402	2.36
Octamantane #11	8-11	85	289	1445	2.43
Nonamantane #1	9-1	89	297	1487	2.50
Decamantane #1	10-1	83	285	1423	2.40
Decamantane #2	10-2	—	—	—	—
Undecamantane#1	11-1	101	355	1774	2.99

ODS HPLC Whatman ODS-II 10/50
(2 Columns in series), acetone mobile phase @5.0 mL/min.

FIG. 36

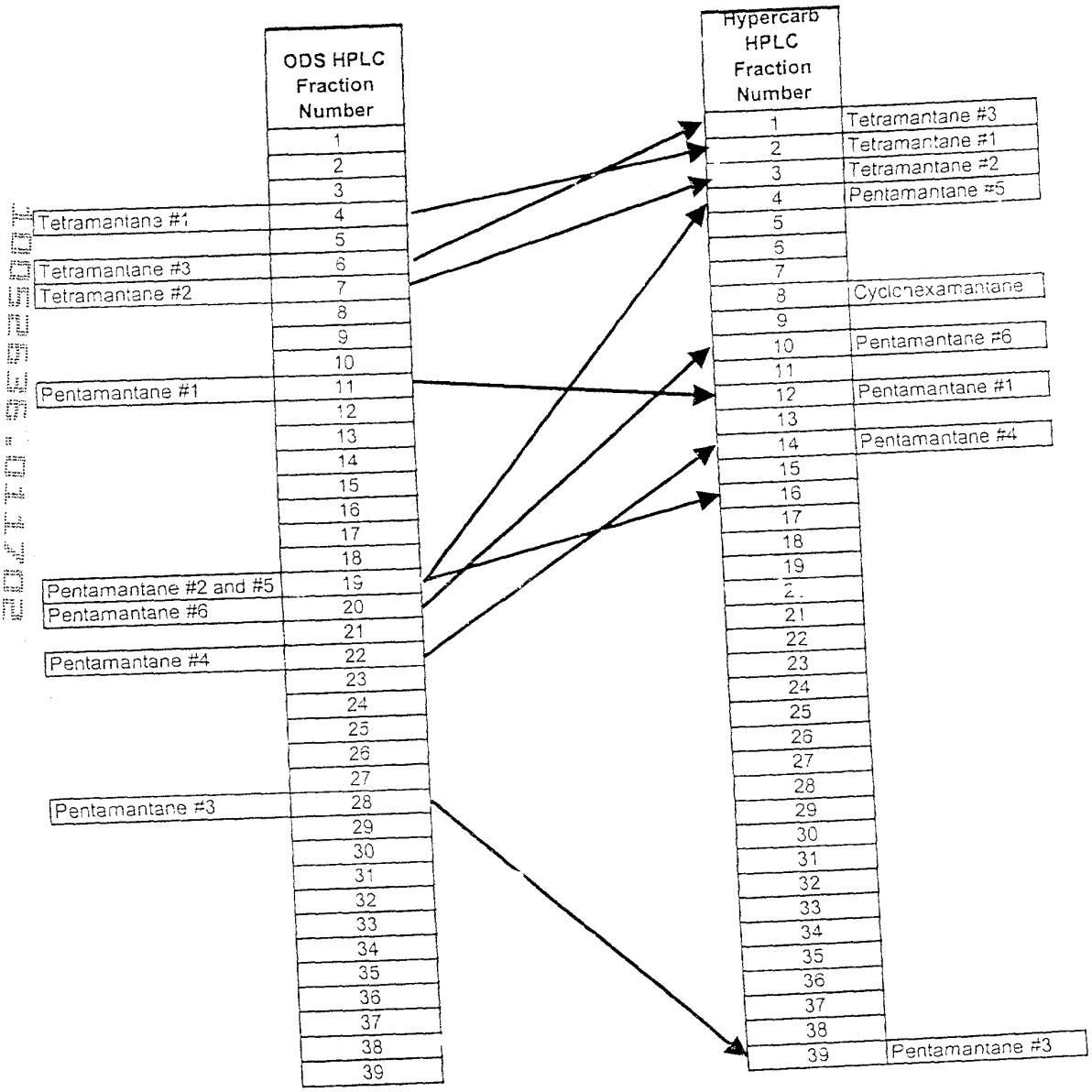

ODS HPLC Fraction Number
Hypercarb HPLC Fraction Number
Tetramantane #1
Tetramantane #3
Tetramantane #2
Pentamantane #1
Pentamantane #2 and #5
Pentamantane #6
Pentamantane #4
Pentamantane #3
Tetramantane #3
Tetramantane #1
Tetramantane #2
Pentamantane #5
Cyclohexamantane
Pentamantane #6
Pentamantane #1
Pentamantane #4
Pentamantane #3

FIG. 37

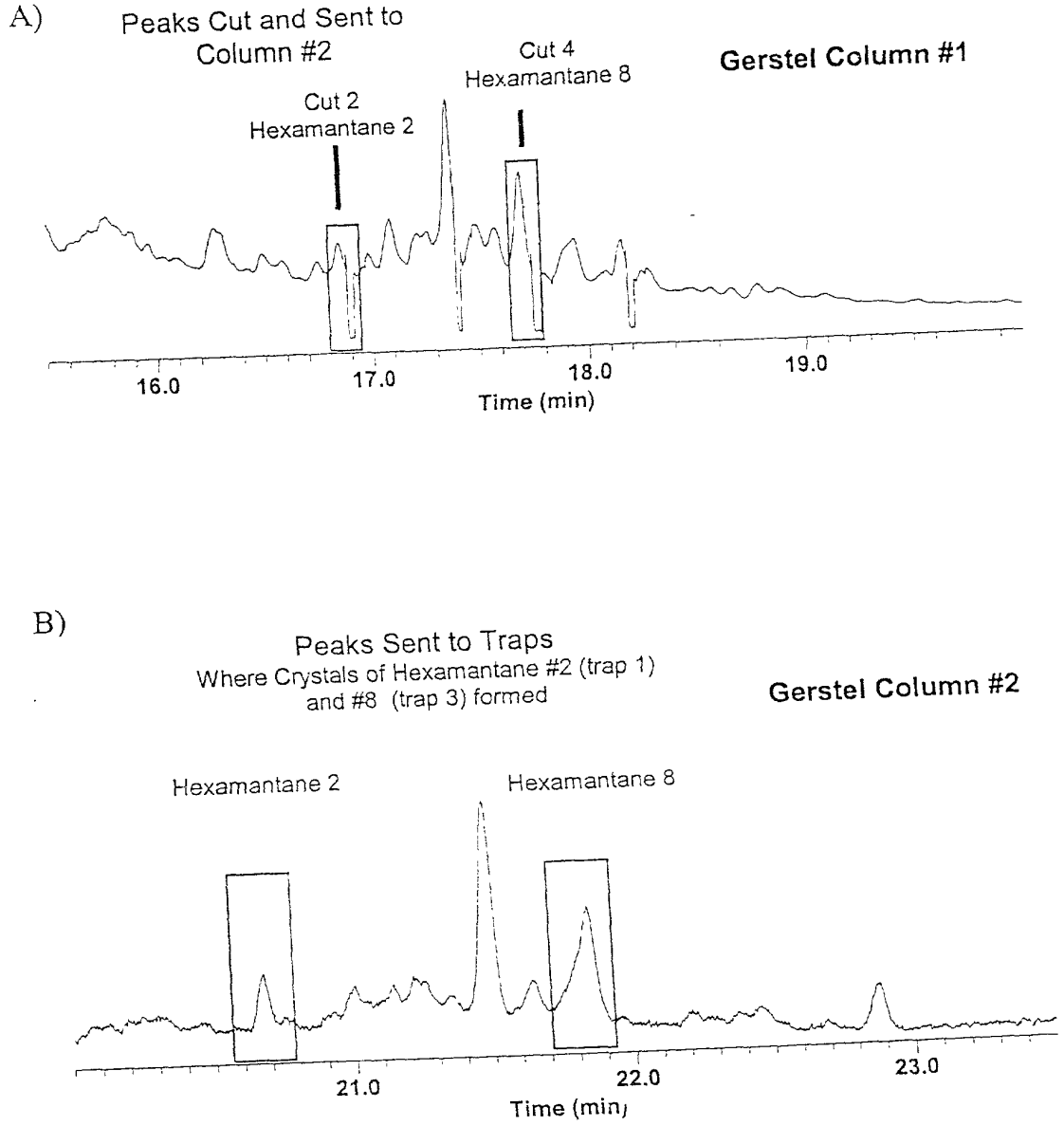


FIG. 38

A)

Crystal of Nonamantane (Mol. Wt. 498)

B)

Mass Spectrum of Dissolved Crystal of Nonamantane
Retention time 19.83 min.

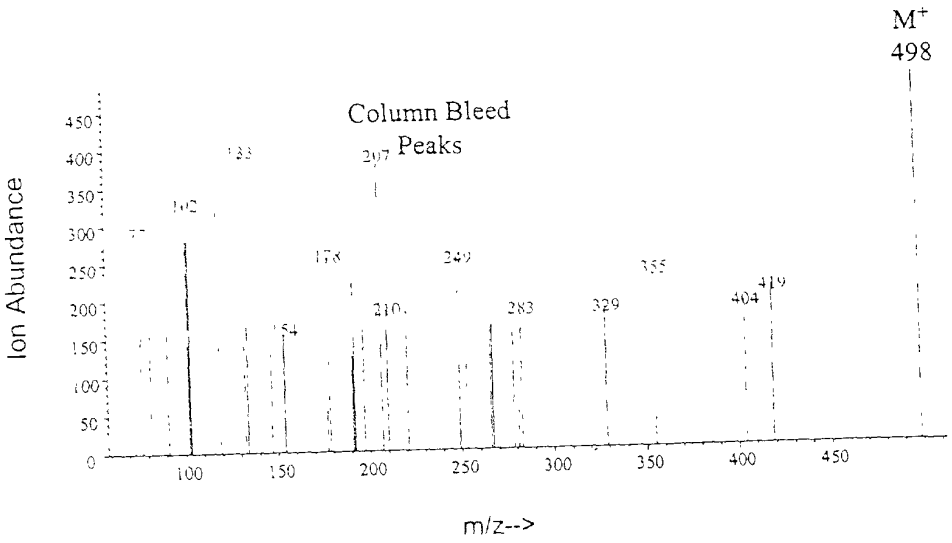


FIG. 39

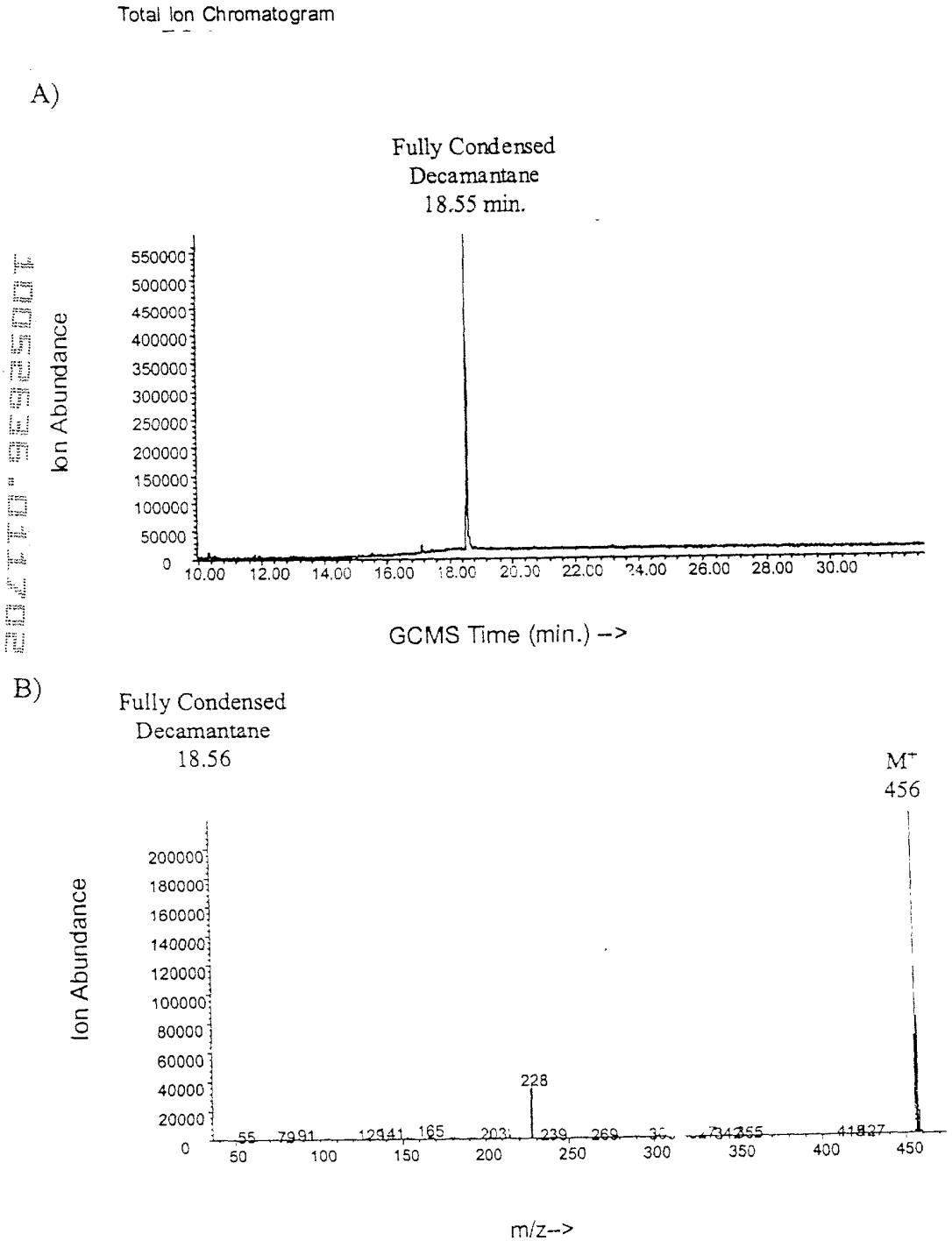

Total Ion Chromatogram
A)
Fully Condensed
Decamantane
18.55 min.
Ion Abundance
550000
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
28.00
30.00
GCMS Time (min.) -->
B)
Fully Condensed
Decamantane
18.56
M+
456
Ion Abundance
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
228
55
79
91
129
141
165
203
239
269
734
255
418
27
50
100
150
200
250
300
350
400
450
m/z-->

FIG. 40

A)

Crystal of Fully Condensed Decamantane

B)

Mass Spectrum of Dissolved Crystal of Fully Comndensed Decamantane
Retention time 18.54 min.